



HND/HNC ASSIGNMENT SPECIFICATION

Student name:		Student P number:	
Programme:	HND Motorsport Engineering / HND Automotive Engineering		
Module:	(Motorsport) Vehicle Dynamics	Module Level (4 or 5):	5
Module code:		Contribution to Overall Module Assessment (%):	
Lecturer:	R A Dowden	Internal Verifier:	Tim Tudor
Assignment Title:	Roll Stiffness Verification	Assignment No (x of x):	2 of 2
Hand Out Date:	13 th February 2013	Submission deadline:	21 st March 2013

Referencing:	In the main body of your submission you must give credit to authors on whose research your work is based. Append to your submission a reference list that indicates the books, articles, etc. that you have read or quoted in order to complete this assignment (e.g. for books: surname of author and initials, year of publication, <u>title of book</u> , edition, publisher: place of publication).			
Disclosure:	I declare that this assignment is all my own work and that I have acknowledged all materials used from the published or unpublished works of other people. All references have been duly cited.			
Student's Signature:	Assignments will not be accepted without a signature here		Date:	
Turnitin: Lecturer to indicate if an electronic version of the assignment must be submitted to Turnitin. Note: the Turnitin version is the primary submission and acts as a receipt for the student. Both electronic and paper versions MUST be submitted by the same deadline. No marks will be released until both submissions are received. Late submission of the electronic version will result in a late penalty grade. Penalties for late submission: Up to one week late, maximum mark of 40%. Over one week late, Refer.			YES	☒
			NO	☐

Learning Outcomes tested (from module syllabus)	Assessment Criteria To achieve each outcome a student must demonstrate the ability to:
Quantify and predict the result of suspension changes on vehicle handling balance	Calculate wheel load distribution for a specified vehicle undertaking a given manoeuvre, specify changes to suspension parameters to change handling characteristics and verify the effect of these changes by practical testing

- Please submit the assignment parts in a suitable report folder or stapled together
- Pages 1 and 2 of this assignment form **MUST** be at the front of the paper submission. Assignments will not be accepted without this form as it is a requirement that you sign the disclosure regarding referencing convention.
- **DO NOT** put this brief into Turnitin or it will match many similarities with other students' submissions.

Student Self Evaluation Form

Student name:		Student P number:	
Programme:	HND/BSc Motorsport Engineering HND/BSc Automotive Engineering	Year of programme	2
Assignment Title:	Roll stiffness verification		

This section repeats in brief the common assessment criteria detailed on previous pages. The *extent* to which these are demonstrated by you determines your grade. Using these criteria, tick the box that best indicates the level of achievement you feel you have achieved with regard to each of them.

Common Assessment Criteria Applied	Level of Achievement						
	REFER		PASS		MERIT	DISTINCTION	
	OUTRIGHT FAIL	UNSATISFACTORY	SATISFACTORY	GOOD	VERY GOOD	EXCELLENT	EXCEPTIONAL
1. Research-informed Literature	0-29% ☐	30-39% ☐	40-49% ☐	50-59% ☐	60-69% ☐	70-79% ☐	80-100% ☐
2. Knowledge and Understanding of Subject	0-29% ☐	30-39% ☐	40-49% ☐	50-59% ☐	60-69% ☐	70-79% ☐	80-100% ☐
3. Analysis	0-29% ☐	30-39% ☐	40-49% ☐	50-59% ☐	60-69% ☐	70-79% ☐	80-100% ☐
4. Practical Application and Deployment	0-29% ☐	30-39% ☐	40-49% ☐	50-59% ☐	60-69% ☐	70-79% ☐	80-100% ☐
5. Skills for Professional Practice	0-29% ☐	30-39% ☐	40-49% ☐	50-59% ☐	60-69% ☐	70-79% ☐	80-100% ☐

PLEASE COMMENT ON AREAS IN WHICH YOU FEEL THAT YOU HAVE PERFORMED WELL	PLEASE COMMENT ON AREAS YOU FEEL THAT YOU NEED TO DEVELOP

Student's Name		Date	
Student's Signature			

TASK DESCRIPTION

The aim of this assignment is compare the roll stiffness results obtained from practical measurement in the workshop with that from calculation.

The results of this assignment will be used in the forthcoming track test to verify the validity of the weight transfer equations developed in class.

Research

Look at references that discuss the relationship between suspension roll stiffness and chassis stiffness and suggest why it is important to be able to measure both values accurately.

Review the various methods of measuring chassis stiffness and evaluate the strengths and weaknesses of the approach adopted in this assignment.

Procedure for workshop test

Initial Measurements

Collect the required data to carry out the calculations including:

1. Front and rear tracks
2. Front and rear spring rates
3. Front motion ratio from WinGeo 3

1. Front Wheel Rate

1. Calculate the wheel rate from the motion ratio detailed in the WinGeo 3 model for the front suspension and the spring rate of the springs fitted to the car..
2. Lock the front right chassis twist lever by putting a jack or stand under it and then find the front left wheel rate by measuring and plotting in Excel wheel travel in mm (y axis) vs load change in N (x axis) . Plot the first order trendline and then the gradient. will be the rate in N/mm (remember to convert the scale reading in kg to N)
3. Compare the measured and calculated wheel rates and see if you can find the reason for any difference.

2. Front Roll Stiffness

1. Calculate the theoretical roll stiffness of the front suspension using the equation developed in class and using the theoretical wheel rate in N/m:

$$K_{\phi f} = \frac{(T_f^2 \times K_{wf})}{2}$$

2. With the car mounted on the chassis pivots **with the rear wheels unsupported** ensure the front wheels are pre-loaded to around 30 kg on the front scales by winding the scale mounts up .
3. Zero the scales
4. Apply a load to the lever at the **rear** of the car and note the load on each front scale. (Remember the recorded load should be in N ie 9.81 x Scale reading)
5. Add the two values, ignoring the sign of the measured value (one will be +ve and the other -ve).
6. Divide by 2 to find average wheel load.
7. Multiply this average load by track to find **Moment** being reacted by the front wheels.
8. Note and record the **front suspension plane roll angle** and the **rear bulkhead plane roll angle**.

9. This can be achieved by clamping ground steel plates to both positions on the chassis and marking on those plates where the gauge is to be placed. When the gauge is moved from one position to the other the result will be reliable and repeatable.
10. Repeat the exercise for a number of loadings (but stop well before you either destroy the chassis or ruin the scales!) Look for consistent results over a number of readings ie the increase in roll for a given load input should be consistent for a number of readings. Measurements taken at low load values are likely to vary significantly as friction and clearances create larger errors.
11. Create a spreadsheet with the results and then plot **Moment** (y axis) vs **front suspension plane roll angle** (x axis). Draw the 1st order trendline and the the roll stiffness will be the gradient of the trend line in Nm/deg

3.Chassis Stiffness

12. The chassis stiffness can be determined by looking at the results obtained in Task 8.
13. Subtract **front suspension plane roll angle** from **rear bulkhead plane roll angle** to find **Chassis Twist**.
14. Plot **Moment** (y axis) vs **Chassis Twist**.(x axis) Again, draw the first order trendline and then the gradient will be the **Chassis stiffness**

4.Rear Roll Stiffness

15. Repeat the exercise for the rear suspension remembering to use the correct equation for a live axle when calculating the theoretical roll stiffness rather than the independent suspension.:-

$$K_{\phi r} = \frac{(T_{sr})^2 \times K_{ser}}{2}$$

Where:

T_{sr} = rear spring track

K_{ser} = effective rear spring rate which is $K_{sr} * MR^2$

$MR = \cos \Theta$ where Θ = the angle of the spring to the vertical.

In the case of the Ford Locost the springs are vertical ie $\cos \Theta = 1$ so $K_{sr} = K_s$

16. With the car still mounted on the chassis pivots but now **with the front wheels unsupported** ensure the rear wheels are pre-loaded to around 30 kg on the rear scales by winding the scale mounts up. Again, apply the load to the bar at the **rear** of the car.
17. As the car rolls each trailing link has to twist. There is no play in the joints and the poly bushes used have an extremely high rate in twist so the only way roll can occur is by twisting of the trailing arms. To determine the effect of this remove the rear road springs and repeat the rear suspension twist test. This will yield a roll stiffness due to the trailing arms alone. If this value is added to the calculated roll stiffness of the rear suspension it **should** give the same result as the measured roll stiffness for the rear suspension with the springs installed. Comment on any difference that is actually produced .

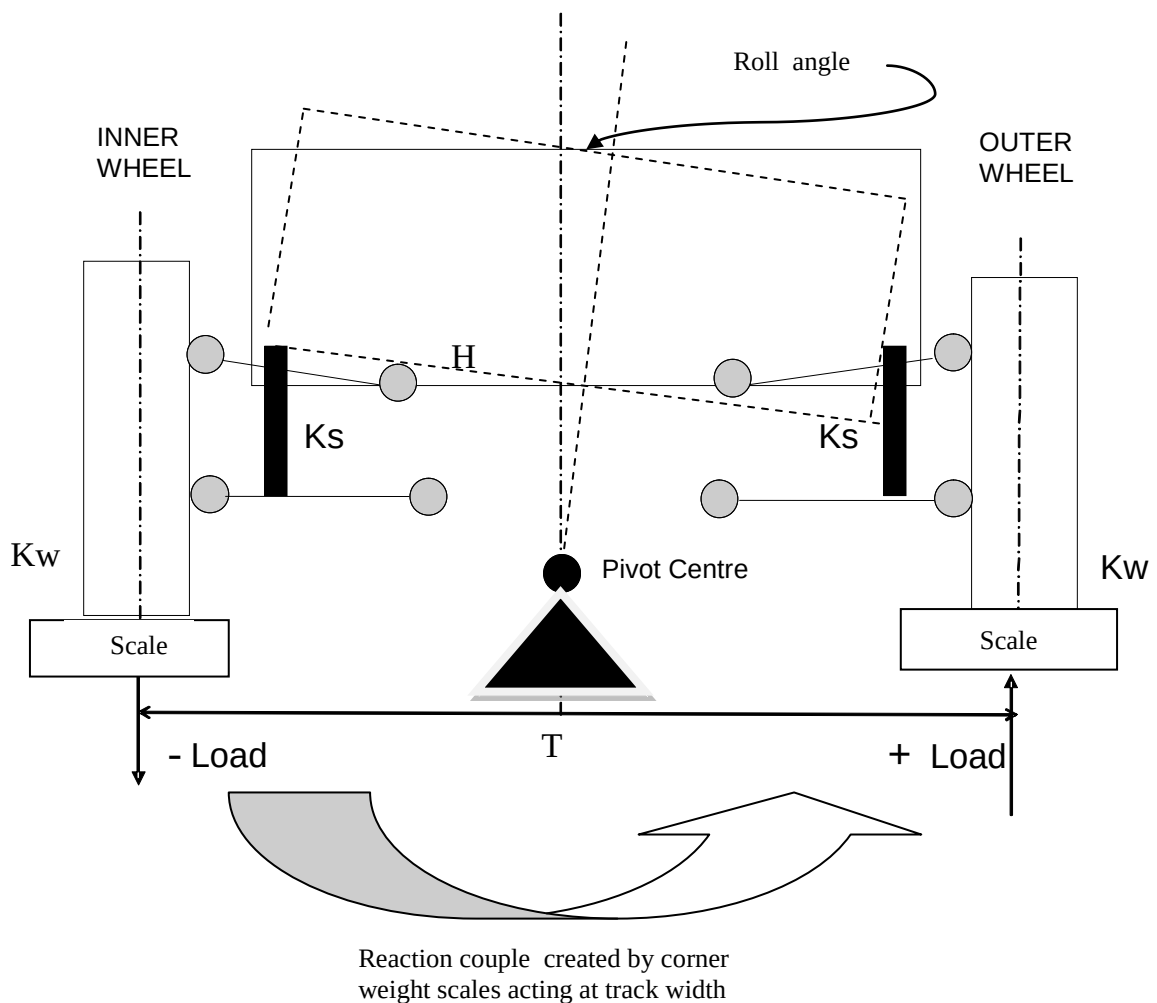
GUIDANCE FOR STUDENTS IN THE COMPLETION OF TASKS

Theory behind the test

When a car corners it is assumed that the lateral acceleration creates the de'Alemberts force acting at the CG to create an overturning moment. By applying a vertical force on a lever arm at the front or rear of the chassis an equivalent overturning moment can be created. As it is not acting at the CG of the car and the chassis stiffness is not infinite, the test has to be conducted for one axle at a time and the overturning moment is then measured as the reaction couple generated by the two wheels of the axle being measured rather than at the point of input.

The measurement of the angle of the chassis at the input end is undertaken to enable the chassis stiffness to be determined.

Although it is not strictly accurate to mount the car on a fixed roll axis in this way it is a way to obtain an indication of how the car will behave on track.

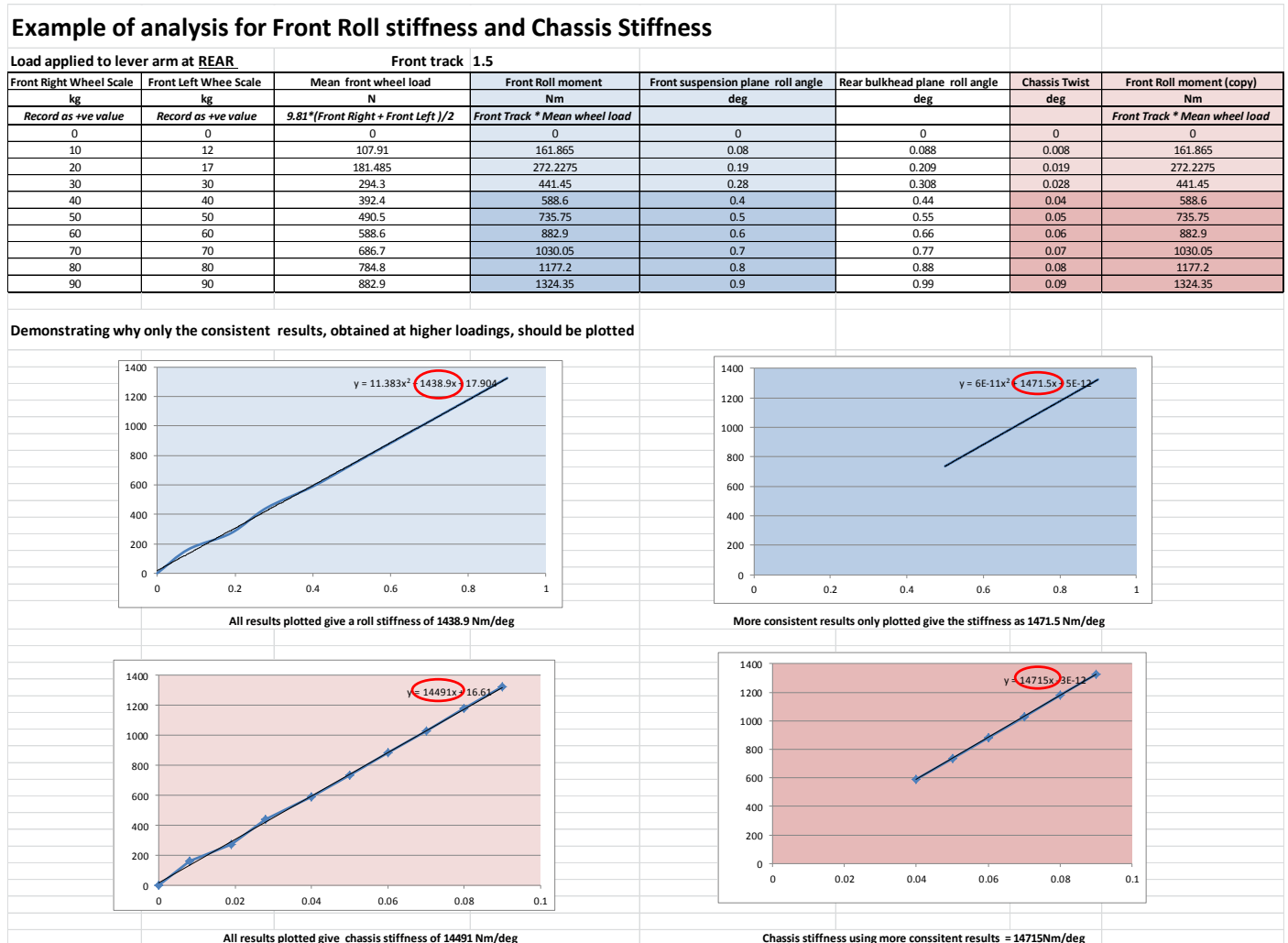


Analysis

An example of the layout for the analysis of the data for the front suspension and the chassis roll stiffness is shown below. This uses sample data and does not represent the actual values you will obtain.

A similar analysis will be needed for the rear suspension but obviously chassis stiffness will not be required again. You could do this as a separate spreadsheet or attach the extra columns to this layout.

Remember you will be measuring the rear twice – once with springs and dampers and once without. The difference between the two roll stiffnesses is the roll stiffness produced the springs alone and this is the value that should be compared with the theoretical value of rear roll stiffness.



GRADING CRITERIA AND STUDENT FEEDBACK

This section details the assessment criteria. The *extent* to which these are demonstrated by you determines your grade. The weightings available for each criterion are shown. Lecturers will use the space provided to comment on the achievement of the task(s), including those areas in which you have performed well and areas that would benefit from development/improvement.

Common Assessment Criteria Applied	Percentage weighting	Grade awarded
1. Research-informed Literature Extent of research and/or own reading, selection of credible sources, application of appropriate referencing conventions.		
Research into the relationship between suspension roll stiffness and chassis stiffness and why it is important to be able to measure both values accurately. Review the various methods of measuring chassis stiffness and evaluate the strengths and weaknesses of the approach adopted in this assignment.	10	
2. Knowledge and Understanding of Subject Extent of knowledge and understanding of concepts and underlying principles associated with the discipline.		
This is an overall assessment of your understanding of the assignment and you can demonstrate this by clearly explaining the procedure adopted and what is being demonstrated by each part of it. Where the procedure has limitation in accuracy or validity compared with the real world you should highlight these and suggest possible improvements in technique or procedure.	20	
3. Analysis Analysis, evaluation and synthesis; logic, argument and judgement; analytical reflection; organisation of ideas and evidence		
In this section you will be assessed on the way you analyse the values you obtained by measurement and theoretical calculation. You should collect all the values - measured, calculated and theoretical together and then compare the theoretical and measured results and suggest reasons for differences between them.	20	
4. Practical Application and Deployment Deployment of methods, materials, tools and techniques; application of concepts; formulation of innovative and creative solutions to solve problems.		
In this section you will be assessed on your success in carrying out the test procedure and complete the calculations to determine:- 1. Front wheel rate - theoretical and measured 2. Front roll stiffness - theoretical and measured 3. Chassis stiffness 4. Rear Roll Stiffness with and without springs - theoretical and measured. You should present all the theoretical calculations and the results obtained and produce clear screen dumps of the spreadsheets required for data collection and analysis and details of the equations used in the spreadsheets. Entering data into a spreadsheet as it is measured to highlight measurement errors as they occur and correcting them, would enable you to demonstrate clearly that you have good skills in this area.	40	
5. Skills for Professional Practice Attributes in professional practice: individual and collaborative working; deployment of appropriate media; presentation and organisation.		
This section assesses the quality of the report that you produce and also reflects the personal input you make in the practical measurement activity. This would be demonstrated by your general involvement, turning up promptly for the test and having data collection sheets already produced to	10	

COMMON ASSESSMENT AND GRADING CRITERIA

Assessment Criteria	OUTRIGHT FAIL	UNSATISFACTORY	SATISFACTORY	GOOD	VERY GOOD	EXCELLENT	EXCEPTIONAL
	REFER (equivalent to 0-29%)	REFER (equivalent to 30-39%*	PASS (equivalent to 40-49%)	PASS (equivalent to 50-59%)	MERIT (equivalent to 60-69%)	DISTINCTION (equivalent to 70-79%)	DISTINCTION (equivalent to 80-100%)
1. Research-informed Literature Extent of research and/or own reading, selection of credible sources, application of appropriate referencing conventions	Little or no evidence of reading. Views and findings unsupported and non-authoritative. Referencing conventions largely ignored.	Poor evidence of reading and/or of reliance on inappropriate sources, and/or indiscriminate use of sources. Referencing conventions used inconsistently.	References to a limited range of mostly relevant sources. Some omissions and minor errors. Referencing conventions evident though not always applied consistently.	Inclusion of a range of research-informed literature, including sources retrieved independently. Referencing conventions mostly consistently applied.	Inclusion of a wide range of research-informed literature, including sources retrieved independently. Selection of relevant and credible sources. Very good use of referencing conventions, consistently applied.	A comprehensive range of research informed literature embedded in the work. Excellent selection of relevant and credible sources. High-level referencing skills, consistently applied.	Outstanding knowledge of research-informed literature embedded in the work. Outstanding selection of relevant and credible sources. High-level referencing skills consistently and professionally applied.
2. Knowledge and Understanding of Subject Extent of knowledge and understanding of concepts and underlying principles associated with the discipline.	Major gaps in knowledge and understanding of material at this level. Substantial inaccuracies.	Gaps in knowledge, with only superficial understanding. Some significant inaccuracies.	Evidence of basic knowledge and understanding of the relevant concepts and underlying principles.	Knowledge is accurate with a good understanding of the field of study.	Knowledge is extensive. Exhibits understanding of the breadth and depth of established views.	Excellent knowledge and understanding of the main concepts and key theories. Clear awareness of challenges to established views and the limitations of the knowledge base.	Highly detailed knowledge and understanding of the main theories/concepts, and a critical awareness of the ambiguities and limitations of knowledge.
3. Analysis Analysis, evaluation and synthesis; logic, argument and judgement; analytical reflection; organisation of ideas and evidence	Unsubstantiated generalisations, made without use of any credible evidence. Lack of logic, leading to unsupported/missing conclusions. Lack of any attempt to analyse, synthesise or evaluate.	Some evidence of analytical intellectual skills, but for the most part descriptive. Ideas/findings sometimes illogical and contradictory. Generalised statements made with scant evidence. Conclusions lack relevance.	Evidence of some logical, analytical thinking and some attempts to synthesise, albeit with some weaknesses. Some evidence to support findings/ views, but evidence not consistently interpreted. Some relevant conclusions and recommendations, where relevant	Evidence of some logical, analytical thinking and synthesis. Can analyse new and/or abstract data and situations without guidance. An emerging awareness of different stances and ability to use evidence to support the argument. Valid conclusions and recommendations, where relevant	Sound, logical, analytical thinking; synthesis and evaluation. Ability to devise and sustain persuasive arguments, and to review the reliability, validity & significance of evidence. Ability to communicate ideas and evidence accurately and convincingly. Sound, convincing conclusions / recommendations.	Thoroughly logical work, supported by evaluated evidence. High quality analysis, developed independently or through effective collaboration. Ability to investigate contradictory information and identify reasons for contradictions. Strong, persuasive, conclusions, justifiable recommendations.	Exceptional work; judiciously selected and evaluated evidence. Very high quality analysis, developed independently or through effective collaboration. Ability to investigate contradictory information and identify reasons for contradictions. Highly persuasive conclusions
4. Practical Application and Deployment Effective deployment of appropriate methods, materials, tools and techniques; extent of skill demonstrated in the application of concepts to a variety of processes and/or contexts; formulation of innovative and creative solutions to solve problems.	Limited or no use of methods, materials, tools and/or techniques. Little or no appreciation of the context of the application.	Rudimentary application of methods, materials, tools and/or techniques but without consideration and competence. Flawed appreciation of the context of the application.	An adequate awareness and mostly appropriate application of well established methods, materials, tools and/or techniques. Basic appreciation of the context of the application.	A good and appropriate application of standard methods, materials, tools and/or techniques. Good appreciation of the context of the application, with some use of examples, where relevant.	A very good application of a range of methods, materials, tools and/or techniques. Very good consideration of the context of the application, with perceptive use of examples, where relevant. Evidence of some innovation and creativity.	An advanced application of a range of methods, materials, tools and/or techniques. The context of the application is well considered, with extensive use of relevant examples. Application and deployment extend beyond established conventions. Innovation and creativity evident throughout.	Outstanding levels of application and deployment skills. Assimilation and development of cutting edge processes and techniques.
5. Skills for Professional Practice Demonstrates attributes expected in professional practice including: individual initiative and collaborative working; deployment of appropriate media to communicate (including written and oral); clarity and	Communication media is inappropriate or misapplied. Little or no evidence of autonomy in the completion of tasks. Work is poorly structured and/or largely incoherent.	Media is poorly designed and/or not suitable for the audience. Poor independent or collaborative initiative. Work lacks structure, organisation, and/or coherence	Can communicate in a suitable format but with some room for improvement. Can work as part of a team, but with limited involvement in group activities. Work lacks coherence in places and could be better structured.	Can communicate effectively in a suitable format, but may have minor errors. Can work effectively as part of a team, with clear contribution to group activities. Mostly coherent work and is in a suitable structure.	Can communicate well, confidently and consistently in a suitable format. Can work very well as part of a team, with very good contribution to group activities. Work is coherent and fluent and is well structured and organised.	Can communicate professionally and, confidently in a suitable format. Can work professionally within a team, showing leadership skills as appropriate, managing conflict and meeting obligations. Work is coherent, very fluent and is presented professionally.	Can communicate with an exceptionally high level of professionalism. Can work exceptionally well and professionally within a team, showing advanced leadership skills. Work is exceptionally coherent, very fluent and is presented professionally.

effectiveness in presentation and organisation.							
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